Resonance decay effects on anisotropy parameters

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One of the surprising results from RHIC is the number-of-constituent-quark (NCQ) dependence of both the elliptic flow v_2 and the nuclear mortification factor R_{CP} at intermediate p_T ($1.5 < p_T < 5$ GeV/c) [1, 2]. Coalescence models can explain these observations whereas the conventional treatment of fragmentation fails [3–5]. In coalescence models, the NCQ-scaled v_2 reveals the flow developed during a partonic epoch. Pion v_2, however, appears to violate the predicted NCQ-scaling [3]. We show that when resonance decays are taken into account, the v_2 of primary pions may be consistent with NCQ-scaling.

In Fig.1(a), we show $\pi^+ + \pi^-$, K_S^0, $p + \overline{p}$, and $\Lambda + \overline{\Lambda}$ v_2 from minimum-bias $Au + Au$ collisions at $\sqrt{s_{\rm NN}}$ = 200 GeV [1, 2]. For $p_T < 1.0$ GeV/c, hydrodynamic calculations [6] reproduce the observed mass dependence. At $p_T \geq 2$ GeV/c, in contradiction to the hydrodynamic model predictions, v_2 becomes flat with v_2 of baryons saturating at higher p_T and with a larger value than that of mesons. Coalescence models [5] predict that after scaling v_2 and p_T by the number of constituent quarks (n), $v_2(p_T/n)/n$ for all particles should fall onto one universal curve. Fig.1(b) shows that for $p_T/n >$ 0.6 GeV/c $v_2(p_T/n)/n$ is similar for all particles except pions. This observation, coupled with the NCQ-dependence observed at intermedieate p_T in the nuclear modification factor R_{AA} provides strong evidence for the presence of hadron formation by coalescence or recombination. Since $v_2(p_T/n)/n$ is thought to characterize the constituent quark v_2, most likely arising during a quark-gluon-plasma (QGP) phase, it is imperative that we understand the deviation of pion v_2 from NCQ-scaling.

With this goal in mind, we study the effect of secondary pions (from resonance decays) on the measured pion v_2. We assume that NCQ scaling is valid for all hadrons and parameterize $v_2(p_T/n)/n$ using the published v_2 [1, 2]. The p_T distributions are assumed to be exponential and the slope parameters are taken from experimental results when available.The relevant hadron abundances are determined from chemical fits [7, 8]. Our goal is to study the effect of resonance decays on the observed pion v_2. The direct pion v_2 is model dependent and we do not assume a-priori that it follows NCQ-scaling. The v_2 of the simulated secondary pions is shown as dashed-lines in Fig.1(c). The resonances included in this study are the ρ, ω, K^*, K_S^0 and Δ. The decay $\rho \rightarrow \pi\pi$ with a 100% branching ratio dominates the production of secondary-pions. For a smaller ρ slope parameter T = 300 MeV, the decayed pion v_2 is lower, leaving room for other contributions [9].

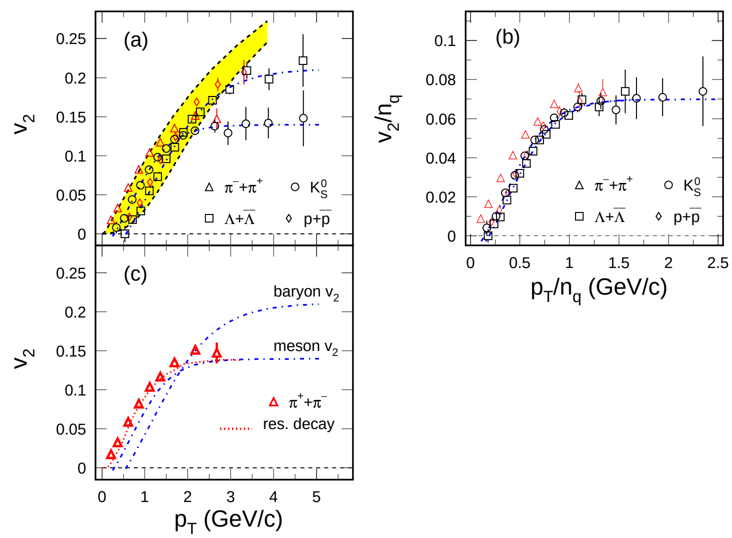

FIG. 1: (a) Experimental results of the transverse momentum dependence of the event anisotropy parameters for π, K_S^0, p, Λ. Dot-dashed lines are the results of fits; (b) Number-of-constituent-quark (NCQ) scaled v_2. All particles except the pions follow the NCQ scaling. The two fitted v_2 distributions, dot-dashed lines, seem also follow the scalling; (c) The measured pion v_2 (symbols) is compared to the simulated v_2 for pions from resonance decays (dashed lines). The v_2 of mesons and baryons are represented by the solid and dot-dashed lines, respectively.

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